CANADA
DEPARTMENT OF MINES
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WATER SUPPLY PAPER No. 86

PRELIMINARY REPORT

GROUND-WATER RESOURCES OF THE RURAL MUNICIPALITY OF .... NO. 47 SASKATCHEWAN

By
B. R. MacKay, H. H. Beach and D. P. Goodall

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INTRODUCTION

Lack of rainfall during the years 1930 to 1934 over a large part of the Prairie Provinces brought about an acute shortage both in the larger supplies of surface water used for irrigation and the smaller supplies of ground water required for domestic purposes and for stock. In an effort to relieve the serious situation the Geological Survey began an extensive study of the problem from the standpoint of domestic uses and stock raising. During the field season of 1935 an area of 80,000 square miles, comprising all that part of Saskatchewan south of the north boundary of township 32, was systematically examined, records of approximately 60,000 wells were obtained, and 720 samples of water were collected for analyses. The facts obtained have been classified and the information pertaining to any well is readily accessible. The examination of so large an area and the interpretation of the data collected were possible because the bedrock geology and the Pleistocene deposits had been studied previously by McLearn, Warren, Rose, Stansfield, Wickenden, Russell, and others of the Geological Survey. The Department of Natural Resources of Saskatchewan and local well drillers assisted considerably in supplying several hundred well records. The base maps used were supplied by the Topographical Surveys Branch of the Department of the Interior.

Publication of Results

The essential information pertaining to the ground water conditions is being published in reports, one being issued for each municipality. Copies of these reports are being sent to the secretary treasurers of the municipalities and to certain Provincial and Federal Departments, where they can be consulted by residents of the municipalities or by other persons, or they may be obtained by writing direct to the Director, Bureau of Economic Geology, Department of Mines, Ottawa. Should anyone require more detailed information than that contained in the reports such additional information as the Geological Survey possesses can be obtained on application to the director. In making such request the applicant should indicate the exact location of the area by giving the quarter section, township, range, and meridian concerning which further information is desired.

The reports are written principally for farm residents, municipal bodies, and well drillers who are either planning to sink new wells or to deepen existing wells. Technical terms used in the reports are defined in the glossary,

How to Use the Report

Anyone desiring information about ground water in any particular locality should read first the part dealing with the municipality as a whole in order to understand more fully the part of the report that deals with the place in which he is interested. At the same time he should study the two figures accompanying the report. Figure 1 shows the surface and bedrock geology as related to the ground water supply, and Figure 2 shows the relief and the location and type of water wells. Relief is shown by lines of equal elevation called "contours". The elevation above sea-level is given on some or all of the contour lines on the figure.

If one intends to sink a well and wishes to find the approximate depth to a water-bearing horizon, he must learn: (1) the elevation of the site, and (2) the probable elevation of the water-bearing bed. The elevation of the well site is obtained by marking its position on the map, Figure 2, and estimating its elevation with respect to the two contour lines between which it lies and whose elevations are given on the figure. Where contour lines are not shown on the figure, the elevations of adjacent wells as indicated in the Table of Well Records accompanying each report can be used. The approximate elevation of the water-bearing horizon at the well-site can be obtained from the Table of Well Records by noting the elevation of the water-bearing horizon in surrounding wells and by estimating from these known elevations its elevation at the well-site.[1] If the water-bearing horizon is in bedrock the depth to water can be estimated fairly accurately in this way. If the water-bearing horizon is in unconsolidated deposits such as gravel, sand, clay, or glacial debris, however, the estimated elevation is less reliable, because the water-bearing horizon may be inclined, or may be in lenses or in sand beds which may lie at various horizons and may be of small lateral extent. In calculating the depth to water, care should be taken that the water-bearing horizons selected from the Table of Well Records be all in the same geological horizon either in the glacial drift or in the bedrock. From the data in the Table

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[1] If the well-site is near the edge of the municipality, the map and report dealing with the adjoining municipality should be consulted in order to obtain the needed information about nearby wells.

of Well Records it is also possible to form some idea of the quality and quantity of the water likely to be found in the proposed well.

GLOSSARY OF TERMS USED

Alkaline. The term "alkaline" has been applied rather loosely to some ground-waters. In the Prairie Provinces, a water is usually described as "alkaline" when it contains a large amount of salts, chiefly sodium sulphate and magnesium sulphate in solution. Water that tastes strongly of common salt is described as "salty". Many "alkaline" waters may be used for stock. Most of the so-called "alkaline" waters are more correctly termed "sulphate waters".

Alluvium. Deposits of earth, clay, silt, sand, gravel, and other material on the flood-plains of modern streams and in lake beds.

Aquifer or Water-bearing Horizon. A water-bearing bed, lens, or pocket in unconsolidated deposits or in bedrock.

Buried pre-Glacial Stream Channels. A channel carved into the bedrock by a stream before the advance of the continental ice-sheet, and subsequently either partly or wholly filled in by sands, gravels, and boulder clay deposited by the ice-sheet or later agencies.

Bedrock. Bedrock, as here used, refers to partly or wholly consolidated deposits of gravel, sand, silt, clay, and marl that are older than the glacial drift.

Coal Seam. The same as a coal bed. A deposit of carbonaceous material formed from the remains of plants by partial decomposition and burial.

Contour. A line on a map joining points that have the same elevation above sea-level.

Continental Ice-sheet. The great ice-sheet that covered most of the surface of Canada many thousands of years age.

Escarpment. A cliff or a relatively steep slope separating level or gently sloping areas.

Flood-plain. A flat part in a river valley ordinarily above water but covered by water when the river is in flood.

Glacial Drift. The loose, unconsolidated surface deposits of sand, gravel, and clay, or a mixture of these, that were deposited by the continental ice-sheet. Clay containing boulders forms part of the drift and is referred to as glacial till or boulder clay. The glacial drift occurs in several forms:

(1) Ground Moraine. A boulder clay or till plain (includes areas where the glacial drift is very thin and the surface uneven).

(2) Terminal Moraine or Moraine. A hilly tract of country formed by glacial drift that was laid down at the margin of the continental ice-sheet during its retreat. The surface is characterized by irregular hills and undrained basins.

(3) Glacial Outwash. Sand and gravel plains or deltas formed by streams that issued from the continental ice-sheet.

(4) Glacial Lake Deposits. Sand and clay plains formed in glacial lakes during the retreat of the ice-sheet.

Ground Water. Sub-surface water, or water that occurs below the surface of the land.

Hydrostatic Pressure. The pressure that causes water in a well to rise above the point at which it is struck.

Impervious or Impermeable. Beds, such as fine clays or shale, are considered to be impervious or impermeable when they do not permit of the perceptible passage or movement of the ground water.

Pervious or Permeable. Beds are pervious when they permit of the perceptible passage or movement of ground water, as for example porous sands, gravel, and sandstone.

Pre-Glacial Land Surface. The surface of the land before it was covered by the continental ice-sheet.

Recent Deposits. Deposits that have been laid down by the agencies of water and wind since the disappearance of the continental ice-sheet.

Unconsolidated Deposits. The mantle or covering of alluvium and glacial drift consisting of loose sand, gravel, clay, and boulders that overlie the bedrock.

Water Table. The upper limit of the part of the ground wholly saturated with water. This may be very near the surface or many feet below it.

Wells. Holes sunk into the earth so as to reach a supply of water. When no water is obtained they are referred to as dry holes. Wells in which water is encountered are of three classes.

(1) Wells in which the water is under sufficient pressure to flow above the surface of the ground. These are called Flowing Artesian Wells.

(2) Wells in which the water is under pressure but does not rise to the surface. These wells are called Non-Flowing Artesian Wells.

(3) Wells in which the water does not rise above the water table. These wells are called Non-Artesian Wells.

NAMES AND DESCRIPTIONS OF GEOLOGICAL FORMATIONS, REFERRED TO IN THESE REPORTS

Wood Mountain Formation. The name given to a series of gravel and sand beds which have a maximum thickness of 50 feet, and which occur as isolated patches on the higher parts of Wood Mountain. This is the youngest bedrock formation and, where present, overlies the Ravenscrag formation.

Cypress Hills Formation. The name given to a series of conglomerates and sand beds which occur in the southwest corner of Saskatchewan, and rests upon the Ravenscrag or older formations. The formation is 30 to 125 feet thick.

Ravenscrag Formation. The name given to a thick series of light-coloured sandstones and shales containing one or more thick lignite coal seams. This formation is 500 to 1,000 feet thick, and covers a large part of southern Saskatchewan. The principal coal deposits of the province occur in this formation.

Whitemud Formation. The name given to a series of white, grey, and buff coloured clays and sands. The formation is 10 to 75 feet thick. At its base this formation grades in places into coarse, limy sand beds having a maximum thickness of 40 feet.

Eastend Formation. The name given to a series of fine-grained sands and silts. It has been recognized at various localities over the southern part of the province, from the Alberta boundary east to the escarpment of Missouri coteau. The thickness of the formation seldom exceeds 40 feet.

Bearpaw Formation. The Bearpaw consists mostly of incoherent dark grey to dark brownish grey, partly bentonitic shales, weathering light grey, or, in places where much iron is present, buff. Beds of sand occur in places in the lower part of the formation. It forms the uppermost bedrock formation over much of western and southwestern Saskatchewan and has a maximum thickness of 700 feet or somewhat more.

Belly River Formation. The Belly River consists mostly of non-marine sand, shale, and coal, and underlies the Bearpaw in the western part of the area. It passes eastward and northeastward into marine shale. The principal area of transition is in the western half of the area where the Belly River is mostly thinner than it is to the west and includes marine zones. In the southwestern corner of the area it has a thickness of several hundred feet.

Marine Shale Series. This series of beds consists of dark grey to dark brownish grey, plastic shales, and underlies the central and northeastern parts of Saskatchewan. It includes beds equivalent to the Bearpaw, Belly River, and older formations that underlie the western part of the area.

WATER-BEARING HORIZONS OF THE MUNICIPALITY

Rural municipality No. 47 is an area of 324 square miles in southwestern Saskatchewan. The municipality consists of nine townships described as tps. 4, 5, and 6, ranges 13, 14, and 15, W. 3rd mer. Beaver Valley post office, situated on the Swift Current-Valmarie highway in the north-central part of the municipality, is approximately 54 miles directly south of the city of Swift Current. There are no railroads or towns and few improved roads in the municipality. The entire area is rolling and in many places unsuited to farming, and is largely given over to ranching.

The greater part of the municipality lies within the drainage basin of Frenchman (locally known as the Whitemud) river and its tributary streams. The river enters the municipality in sec. 30, tp. 5, range 15, flows in a southwesterly direction across the area and crosses the southern boundary in sec. 5, tp. 4, range 13. The elevation of the valley varies from approximately 2,600 feet above sea-level at the point where the river leaves the municipality to approximately 2,775 feet above sea-level at the point of entrance on the western boundary of the area. The ground surface rises rapidly for 100 to 200 feet to the top of the valley and then more gently to the southwest, north, and east to attain summits exceeding 3,000 feet in the southwest corner, along the northern boundary, and at isolated points in the northeast corner of the municipality. The river channel and tributary coulées have been cut through the soft dark shales forming the bedrock of the area, thus developing a deeply dissected, rolling upland with numerous "hogbacks" and small buttes, and giving rise in some places to a typical "badland" type of topography.

The river channel itself is small when compared with the valley it occupies. It carries only a small volume of water throughout most of the year, but provides ample supplies for the local stock requirements in the vicinity of the valley.

The eastern half of the municipality is drained by Denniel creek and its tributaries. Many of the streams head in the highlands along the north and eastern borders of the municipality at an elevation of about 3,000 feet and flow south into the main channel of Denniel creek which joins Frenchman river at an elevation of about 2,600 feet in the vicinity of Valmarie, 1½ miles south of this municipality. Although most of these streams cease flowing in the early summer there is usually ample water left in the deeper parts of the channel for stock. Dams constructed in the small coulées also conserve part of the run-off and form a valuable addition to the stock water supply.

Although the surface run-off probably forms the most important source of water in this area the unconsolidated Recent and glacial deposits and bedrock formations of the municipality either yield, or are potential sources of, ground water throughout the greater part of the municipality. Few, if any, wells have been sunk in the western half of the municipality, and hence less is known regarding the ground water conditions of this part than the more thickly populated eastern townships.

Water-bearing Horizons in the Unconsolidated Deposits

Recent deposits of sands, silts, and more rarely gravels cover the bottom of Frenchman valley and many of the larger tributary valleys and coulées. These deposits represent the accumulation of material washed down during the erosion of the glacial deposits and bedrock formations of the uplands. Ample supplies of water containing varying amounts of salts in solution can be expected from the sand beds in the flats along the bottom of Frenchman valley at depths not usually greater than 30 feet. Water-bearing beds that occur along the edges of the flats and at the confluence of other streams channels generally yield water of better quality than that of the finer sediments of flood-plain deposits of the valley bottoms. Some of the marginal deposits receive their water supplies from springs or from the run-off from the highlands. These waters have less opportunity of dissolving soluble salts from the soil and are usually considered quite suitable for household use. Gravel and sand deposits in the smaller stream channels and coulées can also be expected to yield fair supplies of hard water that can be used for drinking. Many of the wells in the farming communities in the eastern half of the township are situated in these valleys and supply sufficient water for household use and for 20 to 30 head of stock. The depth of these wells is seldom greater than 30 feet.

A mantle of glacial till or boulder clay covers the bedrock throughout the greater part of the municipality. The till was deposited many thousands of years ago by a great continental glacier that passed in a southwesterly direction over the province of Saskatchewan. The thickness of the till varies greatly in this municipality, from only a foot or two along many of the stream valley slopes to 50 or 100 feet over the upland regions. At other places along the slopes the drift is absent and the underlying bedrock is exposed. The till is composed essentially of a heavy, yellow-brown, stony clay which grades into a bluish grey clay at depth. Scattered through the clay are irregular pockets of well sorted sands and gravels. These pockets are usually water bearing. There is generally little evidence on the surface of the existence of these pockets at depth and hence systematic prospecting is often required in order to locate them.

Most of the wells sunk in the boulder clay are situated beside sloughs or artifically constructed reservoirs and derive their water by seepage. These water supplies can be depended upon only while water remains in the reservoir, and may fail in dry seasons. Little, if any, water can be expected from the compact boulder clay itself, as it is not sufficiently porous to allow for large accumulations of ground water, and does not readily yield water to wells.

Wells encountering the porous beds of sand or gravel usually yield sufficient water for 10 to 20 head of stock. The volume of water obtainable from individual pockets depends principally upon the areal extent and porosity, and upon the thickness of the overlying boulder clay. Porous beds buried under thick deposits of impervious clay and entirely surrounded by the clay, have little opportunity of replenishing their water supply. The bases of slopes, low gravel knolls and ridges, and undrained depressions form favorable locations for wells in many parts of drift-covered areas in southern Saskatchewan. In the northeastern half of this municipality extensive gravel deposits have been found in small coulées between ridges. These beds yield large supplies of hard water. The water in some places is highly charged with sulphate salts in solution and is not suitable for household use.

A more porous type of drift, generally referred to as "moraine" and characterized by a more irregularly rolling ground surface covers an approximate area of 25 square miles in the south-west corner of the municipality, as is indicated on the accompanying map (Figure 1). No wells have been sunk in this area, but it is presumed that moderately large supplies of hard, drinkable water will be found at depths not exceeding 30 feet in most parts of it.

Springs are numerous in some localities. They usually occur on the banks of the coulées and most of them derive their supply from the glacial drift. Many of the springs are situated in areas of range land, and if dug out and suitable reservoirs constructed they would contribute a valuable addition to the water supplies for stock.

Water-bearing Horizons in the Bedrock

Three water-bearing bedrock formations underlie the glacial drift in different parts of the municipality. The uppermost of these, referred to as the Ravenscrag formation, is known to occur in only two small areas. One area extends as a belt, approximately 2 miles wide, along the top of the uplands, above an approximate elevation of 2,900 feet above sea-level, in the southern part of township 6, range 15, and the southwestern corner of township 6, range 14. The other area of Ravenscrag extends as a narrow band, with irregular boundaries, along the northern sections of township 6, ranges 13 and 14. Beds of this formation may also underlie the northwestern upland part of township 4, range 15, but a lack of bedrock exposures and of wells makes it difficult to substantiate this opinion.

The strata comprising the Ravenscrag formation consist of thick beds of buff to greenish grey sandstone interbedded with layers of brown to dark grey shales. The sandstone members of this formation are water bearing and give rise to many of the springs along the headwater of Warholes creek in township 6, range 15.

Several wells also yield water from this formation in the north-central part of the municipality. These waters are usually of good quality and the supply obtained is generally ample for local farm requirements.

The Eastend formation, consisting of medium to dark grey shales interbedded with a few thin beds of fine sandstones, underlies the Ravenscrag formation along the northern border of the municipality. It probably nowhere exceeds 30 feet in thickness, and apparently grades into the underlying Bearpaw formation at an elevation of about 2,900 feet above sea-level. The Eastend formation is believed to be absent beneath the Ravenscrag in township 6, ranges 14 and 15. No wells are known to be producing from the Eastend formation in this municipality. The sand beds are sufficiently porous to be water bearing. Waters from this formation in other areas vary considerably in quality. The coarse sand beds yield soft to moderately hard, drinkable water, whereas the more silty and shaly beds give a water that is too highly mineralized for domestic use.

The Bearpaw formation underlies the Eastend and Ravenscrag formations in the areas of their occurrence mentioned above, and either outcrops at the surface or occurs immediately below the drift throughout the remainder of the municipality. The formation is composed of thick beds of dark grey shales interbedded with thin layers of fine grey sandstones. In areas near Warholes creek thick beds of greenish grey sandstones have been noted. The sandstones are probably confined to the upper parts of the formation, whereas at greater depths the formation is composed almost entirely of shale. The shale is readily recognizable by its dark grey colour and soapy feel when wet, and by the small, roughly cubical fragments into which it crumbles upon weathering.

The thickness of the Bearpaw formation in this area has not been determined, but may be about 600 or 700 feet. Outcrops of this formation occur at many places where Frenchman river has cut through the glacial drift.

A few wells in the northern third of the municipality are yielding water from the upper 150 feet of this formation. The water occurs in a fine grey sandstone or in small crevices in the shale. The water is hard and in several places is reported as too highly charged with dissolved sulphate salts to be used for drinking. It is, however, being used for watering stock. The productive sand beds of this formation are believed to be present throughout the northern third of the area and probably in the extreme southwest corner. At all other places erosion which took place before the advent of the continental ice-sheet removed these beds and only the shaly parts of the formation remain. These shales are generally too compact to be water bearing. Several dry holes have been sunk to depths of 50 to 200 feet into the shales of this formation along the eastern borders of the municipality. Many other dry holes have been drilled to various depths into this formation in the municipalities to the south and southwest, bearing out the conclusion that suitable water supplies cannot be expected in this formation below the upper water-bearing, sandy zone in the areas mentioned above. Throughout the greater part of the municipality deep drilling for water is not recommended.

GROUND WATER CONDITIONS BY TOWNSHIPS

Township 4, Range 13

The land surface of this township is for the most part an undulating prairie with a gradual slope to the south. It is well drained by the deep valleys of Denniel creek and its tributaries, which trend in a southwesterly direction through the township. Elevations range from about 2,850 feet on the highlands to slightly less than 2,600 feet in the bed of Denniel creek and in Frenchman valley in the southwestern corner of the township.

The principal ground water supplies are obtained from the Recent sand and gravel deposits in the valley bottoms. These water-bearing beds are generally tapped in wells at depths of less than 20 feet below the surface. The supply is usually sufficient for the average farm requirements and in most places the water is not highly mineralized.

A few isolated pockets of water-bearing gravel or sand have been encountered in wells sunk in the highlands between the valleys. These deposits occur at various depths and are apparently sparsely interspersed through the boulder clay at various elevations down to the base of the glacial drift. A well situated on the NW.$\frac{1}{4}$, section 1, encountered water in a black mud or "muck" at a depth of 90 feet, or an elevation of about 2,617 feet. The water is highly mineralized, smells strongly of hydrogen sulphide, and is reported as being unfit for stock use. The obnoxious odour associated with the water is believed to be the result of the slow decay of vegetable material that was probably laid down during a period of retreat of the ice-sheet, as an accumulation similar to those existing in present day swamps. Such beds are referred to as interglacial deposits. This bed occurs at approximately the same elevation as the creek, but no outcrops of the bed were found along the valley side and definite information is lacking regarding its areal extent. Similar deposits found in municipalities to the north and east are known from well records to extend over several square miles at the same elevation.

On the western side of the township, in the SW.$\frac{1}{4}$, section 19, water was encountered in gravel at a depth of 50 feet, or at an elevation of 2,685 feet above sea-level. This water is reported as being slightly "alkaline", but is used for household purposes as well as for watering stock. Several springs issuing from the bank of Denniel creek derive their supply from an aquifer at about the same elevation, and it may be that this gravel, water-bearing horizon is fairly continuous through the intervening area. Some difficulty has been encountered in locating ground water supplies in the highlands of the east-central part of the township. Two dry holes were drilled in section 23 to depths of 190 and 260 feet. These have doubtless passed through the glacial drift and penetrated the underlying Bearpaw shales. Ground water conditions in these shales are considered to be very poor, and the settlers of this township are well advised to confine their search for water to the unconsolidated stream deposits and the glacial drift.

Township 4, Range 14

This township is a typical range land area, divided in a northwest-southeasterly direction by the broad valley of Frenchman river. The land surface of the highlands north and south of the river are moderately rolling, and are well drained by valleys and coulées tributary to the main valley.

No wells are known to have been sunk in this township. Good supplies of ground water can be expected to occur at a depth of 20 feet or less in the Recent deposits of sand and gravel in the river flats and in the bottoms of the smaller coulées.

There is a notable occurrence of springs along the banks of the river, two of which, located in sections 14 and 18, are indicated on the accompanying map. Most of these springs issue from porous sand or gravel beds in the glacial drift at places where the beds have been exposed by stream erosion. Some of the springs situated along the river flats may be seepage from higher river terraces that have been covered by slumping of the river banks. After excavation of suitable reservoirs these springs can be expected to supply water for large herds of stock.

Shales of the Bearpaw formation are exposed along many of the valleys and weather to form buttes characteristic of "badlands" topography. The shale underlies the drift throughout the remainder of the township. Little if any water can be expected from the shale and settlers are advised to confine their search for ground water to the valley deposits and the glacial drift of the uplands rather than to undertake deep drilling.

Township 4, Range 15

All of this township is ranch land. For the most part it has a rolling surface of high altitudes but in the northern part of the township the upland is gently undulating and in places nearly level. Elevations averaging 3,000 to 3,050 feet prevail through a large area in the central part. An isolated hill, locally known as "Black Horse butte", forms a striking topographic feature in the southeast corner.

No wells are known to have been dug in this township. Recent deposits floor the bottoms of the few stream valleys, but only small or intermittent supplies of ground water can be expected from them.

The glacial drift probably extends to a depth of 100 feet or more, particularly in the central and southwestern parts of the township.

Water-bearing pockets of sand and gravel probably occur in the steeply rolling range of hills composed of moraine that extends in a northwesterly direction across the central and southwestern parts of the township. In the township to the west, where the topographic features are similar, moderate to large supplies of water are obtained from these deposits. Wells located in the depressions between the hillocks generally encounter water at average depths of 15 to 20 feet.

Studies in the municipalities to the west suggest that the Ravenscrag formation may underlie the glacial drift over much of the uplands of the western two-thirds of the township northwest of Black Horse butte. The entire absence of wells or of bedrock outcrops, however, makes it impossible to define the possible areal extent of this formation if present in these parts, and on the map the Bearpaw formation is shown as underlying the glacial drift throughout the township. Should the sandy clays and shales of the Ravenscrag formation be present it is presumable that they will be encountered at depths of 90 to 200 feet from the surface, depending largely upon the thickness of the overlying drift, and that they will yield water of good quality.

The upper part of the Bearpaw formation is believed to have beds of fine sand that may be water bearing. Drilling to greater depths into the underlying shales cannot be expected to yield adequate supplies of ground water.

Township 5, Range 13

Settlement is confined to the southern part of this township. The land surface here is moderately rolling and rises in a northerly direction from an average elevation of 2,725 feet above sea-level at the southern border to over 3,000 feet at the highest point in the northern part of the township. The northern two-thirds of the township is more steeply rolling and is leased for grazing.

Springs along the banks of the creeks provide water for the range stock. In the southern part of the township some difficulty has been encountered in obtaining ground water suitable for human consumption. The principal water supplies are obtained from shallow wells sunk to depths of 10 to 20 feet in the lower slopes and in the bottoms of the valleys. The water-bearing beds are usually gravel; and the yield of the wells is sufficient for household use and in most places for a few head of stock. The farm supply is usually increased by dams constructed in the coulées. One well located in a valley bottom in the NE.$\frac{1}{4}$, section 4, encountered gravel at a depth of 15 feet. This well yields sufficient quantities of hard water for household needs and for watering 60 head of stock. The yield is larger than is to be expected in general, but the occurrence suggests the advisability of carefully prospecting the stream deposits.

The thickness of the glacial drift no doubt varies considerably in different parts of the township, as parts of the drift covering have been removed by stream erosion, but it probably even here exceeds 30 feet. Holes bored on the higher slopes and ridges have passed through blue clay to a depth of 50 feet. Some of these wells are believed to have penetrated the soft marine shales of the underlying Bearpaw formation.

A well situated on the NW.¼, section 9, yields a supply of water sufficient for 10 head of stock, from what is reported to be blue clay at a depth of about 34 feet. This well is regarded as deriving most of its supply from the contact of the drift and Bearpaw formation. The water is highly mineralized and not suitable for drinking because of its bitter taste and laxative effects.

In the southeastern corner of the township, in sections 1 and 12 shallow wells sunk in clay or penetrating a few feet of the underlying shales yield highly mineralized water that is unfit even for stock. Wells have been bored to depths of 90 to 125 feet in these sections without obtaining water.

It seems improbable that supplies of water suitable for household use or even for stock can be obtained from the boulder clay or the bedrock shales in this township, and the settlers are advised to confine their search for water to the shallow porous deposits of the lower slopes and valley bottoms.

Township 5, Range 14

This township consists of plateau land in the northern and eastern parts with surface elevations of slightly over 2,900 feet above sea-level. The plateau is dissected in the eastern and central parts by tributary stream valleys of Frenchman river. The land surface slopes abruptly from the highlands southward to the edge of Frenchman valley in the southwestern part of the township. Badland topography is developed in places on the lower slopes of the valley and tributary ravines.

The ground water supply of the township has not been developed, as most of the area is devoted to grazing. Ground water conditions in the Recent deposits along Frenchman river and Denniel creek and tributaries are probably similar to those found along these streams in the townships already discussed. These stream deposits are considered to be the best potential sources of ground water in the township and water should be found in them within 30 feet of the surface.

Glacial deposits are thin over most of the township and the Bearpaw shales are exposed at many places along the southern slopes. Early glacial or pre-glacial gravels may occur at the base of the drift in some of the northern sections. A well sunk to a depth of 30 feet in the NE.$\frac{1}{4}$, section 36, encountered an abundant supply apparently from this type of deposit. The water is under hydrostatic pressure and rises to a point 8 feet below the surface. It is hard and reported as being slightly "alkaline", but is used for drinking.

Springs occurring on the edge of the highlands in sections 32 and 33 may derive their water from glacial gravels or from sandy beds at the top of the Bearpaw formation. Throughout most of the township, however, the Bearpaw formation is composed almost entirely of shale and cannot be regarded as a source of ground water suitable for either household or stock raising requirements.

Township 5, Range 15

Frenchman river valley trends in a southeasterly direction through the centre of this township of range land. The alluvial deposits of the river and of tributary streams together with the debris washed down from the river banks have formed extensive areas of comparatively level ground in the valley bottom. The land surface rises steeply from an elevation of about 2,800 feet in the river valley to over 2,900 feet on the plateau area in the southwestern part and along the north and northeastern borders of the township. The plateau areas on either side of the river valley are deeply dissected by valleys, and extensive tracts of badlands have been formed in this way.

The principal ground water supplies of this township probably occur in the alluvial material in the valley bottoms and along the lower slopes. As a large part of these sediments is derived from the erosion of the bedrock shales and boulder clay the ground waters of these stream deposits will no doubt carry relatively large amounts of the soluble salts that are commonly found in these deposits.

Glacial drift may attain a thickness of 50 feet or more on the highlands in the southwestern corner of the township, but is only a few feet thick along the valley slopes; it is absent over extensive areas where the shales of the Bearpaw bedrock formation are exposed at the surface. Little if any ground water can be expected to occur in the drift of this township where it has not been sorted and re-deposited by stream action.

The Ravenscrag formation may possibly occur beneath the drift along the south and western margins of the township south of the river. Sand members of this formation should yield water of good quality in this area at depths of considerably less than 100 feet, depending upon the thickness of the drift. The sand beds of the Bearpaw formation are exposed in a few places along the creeks. The sand is generally very fine and may not form an aquifer for any large supply of water, but it is possible that in some parts of the highlands it may prove to be water bearing and can be tapped at reasonable depths. Deep drilling in this township cannot be expected to yield water satisfactory either in quality or quantity for domestic or stock requirements.

Township 6, Range 13

The land surface of the greater part of this township is steeply rolling. It is well drained by numerous southward flowing streams which have cut deep channels into the highlands. The elevation of the surface varies from approximately 2,850 feet in the lower stream channels to slightly over 3,000 feet above sea-level in the highlands.

Only a few wells have been sunk in this area as the greater part of the township is used for grazing.

Recent stream deposits of sand and gravel occur in bottoms of the valleys. Wells sunk in these deposits encounter fair supplies of water at an average depth of about 15 feet. Soft water is reported from one of these wells, and in no instance is the water considered to be too highly mineralized for drinking. In the highlands the glacial drift probably is not more than 30 feet thick. Most of the wells sunk in the boulder clay of the highlands encountered water in what is reported as blue clay or shale, at depths ranging from 30 to 35 feet. Although part of the water from these wells is believed to come from the contact between the drift and the underlying bedrock shales of the Bearpaw or Eastend formations, some of it is derived from small crevasses in the partly weathered surface of the bedrock, and, consequently, the wells are considered to be bedrock wells.

The supply from many of these wells decreased during the extended period of drought from 1930 to 1934, but the average yield was sufficient for household use and for 10 to 20 head of stock. The water is hard and in some places is reported as being slightly "alkaline", but is used for drinking.

Several springs occur on the banks of the creeks in the range land. The source of these water supplies was not determined, but the water probably comes to the surface from the contact of the drift and the bedrock.

The Ravenscrag formation is thought to underlie the glacial drift in the highlands along the northern and eastern borders of the township at an approximate elevation of about 2,950 to 3,000 feet above sea-level. Beds of sandstone or sandy shale will probably yield good supplies of water at depths between 50 and 100 feet in this area.

The Eastend formation underlying the Ravenscrag is believed to extend for about a mile farther south. The Bearpaw formation underlies the glacial drift throughout the remainder of the township. Thin beds of fine sandstone occur in the shales of these two formations in the townships to the west and east of this area. Wells sunk to these aquifers usually yield good supplies of water, but the concentration of salts in solution in some of the waters prohibits their use in the household. They are being used, however, for watering stock. These water-bearing beds probably occur in this township at elevations between 2,950 and 2,750 feet above sea-level. Beds sufficiently porous to form a reservoir for ground water are not to be expected at greater depths in this formation.

Township 6, Range 14

This township is for the most part an irregularly rolling upland with a general slope to the southeast from an average elevation of about 3,000 feet along the northern border to about 2,800 feet above sea-level in the bed of Denniel creek in the southeastern corner.

The northern highlands are dissected by the deep coulées of several small creeks. These streams converge along the eastern border of the township and enter the main channel of Denniel creek, which occupies a wide valley.

Alluvial deposits of sand and gravel occur in the valley bottoms. Wells sunk in these beds to a depth of 20 feet or less generally yield moderate to large supplies of water. The water is hard and in a few instances, especially in the southeastern part of the township, noticeable amounts of salts in solution are present. The water is being used as a domestic drinking supply as well as for watering stock.

The western half or more of this township is devoted to grazing and little is known regarding the thickness of the glacial drift or ground water conditions in this area.

A few wells situated in the farming community on the eastern side of the township yield water from beds of sand underlying blue clay at depths generally less than 20 feet from the surface. As most of these wells are located on the lower slopes of the hills they are probably obtaining their water from material washed down from the hills after the deposition of the glacial drift.

Many wells have been sunk through the glacial boulder clays into the underlying bedrock without encountering more than mere seepages of highly mineralized water.

Water-bearing horizons in the glacial drift in this area are apparently scarce, and are not expected to be appreciably more numerous in the western part of the township.

The most reliable water-bearing horizons in the township occur in the underlying bedrock formations. Two wells situated on the NE.$\frac{1}{4}$, section 27, and SE.$\frac{1}{4}$, section 34, are believed to derive their water supply from coarse sand or sandstone beds in the Ravenscrag formation. The sand occurs at an approximate elevation of 2,950 feet, or at depths of 77 feet and 90 feet respectively. This formation occurs along the northern border of the township and is confined to areas above an elevation of 2,940 feet. The water in the wells cited is under hydrostatic pressure and rises in the holes 10 to 12 feet above the aquifer. The water is reported to be soft to moderately hard, and is used in the households and for watering stock.

Two wells located in the NW.$\frac{1}{4}$, section 23, and NE.$\frac{1}{4}$, section 24, yield large supplies of water from sand beds that occur either in the Eastend formation or the upper part of the Bearpaw formation at elevations of 2,840 and 2,930 feet respectively. The water from the higher horizon is moderately soft and suitable for drinking. The other well tapping a slightly lower horizon yields a more highly mineralized water. Here the residents are obliged to use the creek for a drinking water supply. The deepest water-bearing horizon in the bedrock occurs at an elevation of about 2,790 feet above sea-level. A well situated in section 30 encountered this horizon at a depth of 135 feet. A small supply of water is obtained from this well. It occurs in a fine sand or sandy clay, is hard and highly mineralized, and is used only for watering stock.

In the southeastern part of the township good yields of water are obtained at about the same elevation from wells sunk to depths of 46 and 12 feet, respectively, in sections 1 and 12. This water is hard, but not too highly mineralized to be used for drinking. None of these aquifers is expected to have a wide areal extent, and others may occur elsewhere in the township at intermediate elevations.

Township 6, Range 15

An upland area with an average elevation of about 3,000 feet above sea-level extends in an easterly direction through the central part of this township and forms the height of land between the north and south drainage systems. The uplands are undulating and deeply dissected on the northern and southern slopes by steep-sided coulées.

There are no wells in this township, as the entire area is range land. The intermittently flowing streams and springs in the valleys are the best sources of water for stock watering in the area. Recent deposits are confined to small areas in the bottoms of the coulées and are not regarded as an important source of water supply compared to the flowing springs.

Glacial drift, consisting principally of clays and scattered beds of quartzite pebbles, covers the highlands as a blanket of unknown thickness. A few scattered water-bearing gravel beds are believed to occur in the glacial drift, particularly near the contact with the underlying bedrock.

Abundant supplies of water of good quality are known to occur in the beds of sandstone, fine sands, and thin lignite coal seams of the Ravenscrag formation. These water-bearing horizons should be encountered at a depth of 100 feet or less on the uplands in the southern half of the township.

Many of the springs that occur in the coulées near the headwaters of Warholes creek, on the southern slope of the highlands, issue from porous beds in the Ravenscrag formation. Some of the springs on the northern slope may also be obtaining their water from these beds beneath a covering by glacial drift.

The underlying Bearpaw formation may possibly be water bearing in other parts of the township, but the water probably will be found to be unsuitable for domestic use and may be unfit for watering stock. Small dams in coulées or excavated reservoirs around springs appear to be the most logical sources of water for stock until testing is done to determine the actual water conditions of the drift and the Ravenscrag formation, and the possibility of productive sand beds occurring in the upper part of the Bearpaw shales.

STATISTICAL SUMMARY OF WELL INFORMATION IN RURAL
MUNICIPALITY OF NO. 47, SASKATCHEWAN

Township	4	4	4	5	5	5	6	6	6	Total No. in Municipality
West of 3rd mer. Range	13	14	15	13	14	15	13	14	15	
Total No. of Wells in township	31	0	0	21	2	0	8	23	0	85
No. of wells in bedrock	2	0	0	4	0	0	4	9	0	20
No. of wells in glacial drift	25	0	0	16	2	0	3	12	0	58
No. of wells in alluvium	4	0	0	0	0	0	1	2	0	7
Permanency of Water Supply										
No. with permanent supply	28	0	0	14	2	0	8	18	0	70
No. with intermittent supply	1	0	0	0	0	0	0	1	0	2
No. dry holes	2	0	0	7	0	0	0	4	0	13
Types of Wells										
No. of flowing artesian wells	0	0	0	0	0	0	0	0	0	0
No. of non-flowing artesian wells	2	0	0	0	2	0	0	3	0	7
No. of non-artesian wells	27	0	0	14	0	0	8	16	0	65
Quality of Water										
No. with hard water	25	0	0	14	2	0	7	17	0	65
No. with soft water	4	0	0	0	0	0	1	2	0	7
No. with salty water	0	0	0	0	0	0	0	0	0	0
No. with "alkaline" water	15	0	0	10	2	0	2	10	0	39
Depths of Wells										
No. from 0 to 50 feet deep	28	0	0	19	2	0	8	17	0	74
No. from 51 to 100 feet deep	1	0	0	1	0	0	0	5	0	7
No. from 101 to 150 feet deep	0	0	0	1	0	0	0	1	0	2
No. from 151 to 200 feet deep	1	0	0	0	0	0	0	0	0	1
No. from 201 to 500 feet deep	1	0	0	0	0	0	0	0	0	1
No. from 501 to 1,000 feet deep	0	0	0	0	0	0	0	0	0	0
No. over 1,000 feet deep	0	0	0	0	0	0	0	0	0	0
How the Water is Used										
No. usable for domestic use	26	0	0	5	2	0	8	13	0	54
No. not usable for domestic use	3	0	0	9	0	0	0	6	0	18
No. usable for stock use	28	0	0	8	2	0	8	19	0	65
No. not usable for stock use	1	0	0	6	0	0	0	0	0	7
Sufficiency of Water Supply										
No. sufficient for domestic needs	27	0	0	14	2	0	8	18	0	69
No. insufficient for domestic needs	2	0	0	0	0	0	0	1	0	3
No. sufficient for stock needs	22	0	0	12	2	0	7	15	0	58
No. insufficient for stock needs	7	0	0	2	0	0	1	4	0	14

ANALYSES AND QUALITY OF WATER

General Statement

Samples of water from representative wells in surface deposits and bedrock were taken for analyses. Except as otherwise stated in the table of analyses the samples were analysed in the laboratory of the Borings Division of the Geological Survey by the usual standard methods. The quantities of the following constituents were determined; total dissolved mineral solids, calcium oxide, magnesium oxide, sodium oxide by difference, sulphate, chloride, and alkalinity. The alkalinity referred to here is the calcium carbonate equivalent of all acid used in neutralizing the carbonates of sodium, calcium, and magnesium. The results of the analyses are given in parts per million--that is, parts by weight of the constituents in 1,000,000 parts of water; for example, 1 ounce of material dissolved in 10 gallons of water is equal to 625 parts per million. The samples were not examined for bacteria, and thus a water that may be termed suitable for use on the basis of its mineral salt content might be condemned on account of its bacteria content. Waters that are high in bacteria content have usually been polluted by surface waters.

Total Dissolved Mineral Solids

The term "total dissolved mineral solids" as here used refers to the residue remaining when a sample of water is evaporated to dryness. It is generally considered that waters that have less than 1,000 parts per million of dissolved solids are suitable for ordinary uses, but in the Prairie Provinces this figure is often exceeded. Nearly all waters that contain more than 1,000 parts per million of total solids have a taste due to the dissolved mineral matter. Residents accustomed to the waters may use those that have much more than 1,000 parts per million of dissolved solids without any marked inconvenience, although most persons not used to highly mineralized water would find such waters highly objectionable.

Mineral Substances Present

Calcium and Magnesium

The calcium (Ca) and magnesium (Mg) content of water is dissolved from rocks and soils, but mostly from limestone, dolomite, and gypsum. The calcium and magnesium salts impart hardness to water. The magnesium salts are laxative, especially magnesium sulphate (Epsom salts, $MgSO_4$), and they are more detrimental to health than the lime or calcium salts. The calcium salts have no laxative or other deleterious effects. The scale found on the inside of steam boilders and tea-kettles is formed from these mineral salts.

Sodium

The salts of sodium are next in importance to those of calcium and magnesium. Of these, sodium sulphate (Glauber's salt, Na_2SO_4) is usually in excess of sodium chloride (common salt, NaCl). These sodium salts are dissolved from rocks and soils. When there is a large amount of sodium sulphate present the water is laxative and unfit for domestic use. Sodium carbonate (Na_2CO_3) "black alkali", sodium sulphate "white alkali", and sodium chloride are injurious to vegetation.

Sulphates

Sulphates (SO_4) are one of the common constituents of natural water. The sulphate salts most commonly found are sodium sulphate, magnesium sulphate, and calcium sulphate ($CaSO_4$). When the water contains large quantities of the sulphate of sodium it is injurious to vegetation.

Chlorides

Chlorides are common constituents of all natural water and are dissolved in small quantities from rocks. They usually occur as sodium chloride and if the quantity of salt is much over 400 parts per million the water has a brackish taste.

Iron

Iron (Fe) is dissolved from many rocks and the surface deposits derived from them, and also from well casings, water pipes, and other fixtures. More than 0.1 part per million of iron in solution will settle as a red precipitate upon exposure to the air. A water that contains a considerable amount of iron will stain porcelain, enamelled ware, and clothing that is washed in it, and when used for drinking purposes has a tendency to cause constipation, but the iron can be almost completely removed by aeration and filtration of the water.

Hardness

Calcium and magnesium salts impart hardness to water. Hardness of water is commonly recognized by its soap-destroying powers as shown by the difficulty of obtaining lather with soap. The total hardness of a water is the hardness of the water in its original state. Total hardness is divided into "permanent hardness" and "temporary hardness". Permanent hardness is the hardness of the water remaining after the sample has been boiled and it represents the amount of mineral salts that cannot be removed by boiling. Temporary hardness is the difference between the total hardness and the permanent hardness and represents the amount of mineral salts that can be removed by boiling. Temporary hardness is due mainly to the bicarbonates of calcium and magnesium and iron, and permanent hardness to the sulphates and chlorides of calcium and magnesium. The permanent hardness can be partly eliminated by adding simple chemical softeners such as ammonia or sodium carbonate, or many prepared softeners. Water that contains a large amount of sodium carbonate and small amounts of calcium and magnesium salts is soft, but if the calcium and magnesium salts are present in large amounts the water is hard. Water that has a total hardness of 300 parts per million or more is usually classed as excessively hard. Many of the Saskatchewan water samples have a total hardness greatly in excess of 300 parts per million; when the total hardness exceeded 3,000 parts per million no exact hardness determination was made. Also no determination for temporary hardness was made on waters having a total hardness less than 50 parts per million. As the determinations of the soap hardness in some cases were made after the samples had been stored for some time, the temporary hardness of some of the waters as they come from the wells probably is higher than that given in the table of analyses.

Water from the Unconsolidated Deposits

As no samples of ground water were taken for analysis from this municipality the following generalizations regarding the quality of the ground water are based upon observations at the well sites, opinions of residents, and analyses of waters from adjoining municipalities in which the source beds are similar.

Waters derived from the Recent deposits along Denniel creek and its tributaries are hard and, although containing small amounts of dissolved mineral salts washed in by surface water percolating through the boulder clay covering the uplands, they are regarded as being suitable for domestic use. Shallow sources of ground water supply, however, depending for replenishment upon surface waters are particularly liable to contamination by decaying organic matter.

The Recent deposits of Frenchman River valley also derive their supply in part from surface waters coming from the uplands. In this case, however, the surface water passes over the dark grey shales of the Bearpaw formation, carries off the readily dissoluble mineral salts, and collects them in the valley bottom where with evaporation of the water they slowly become concentrated. The silt beds in the valley bottom offer little opportunity for the water to circulate, and thus seem to be very favourable for the accumulation of large concentrations of salts. Hence, water from the silts is generally of very poor quality for drinking. Several different salts are probably present in solution, but Glauber's salt (Na_2SO_4) and Epsom salts ($MgSO_4$) probably occur in the greatest amounts. The waters from the gravels interbedded in the silts and from gravels on the benches along the river are of better quality for domestic use.

Porosity of the beds and the depths of their occurrence below the surface are important factors in determining the quality of waters from the glacial drift. Waters derived from extensive gravel beds near the surface in the upland areas are soft to moderately hard and contain only minor amounts of sulphate salts in solution. Such waters are of good quality for drinking. This condition is to be expected particularly in the moraine-covered district. The water from sand and gravel beds buried under 20 or 30 feet of boulder clay is generally more highly mineralized. Waters slowly percolating through the compact clay have ample opportunity to dissolve mineral salts from the clay. These salts are largely sulphates and when a concentration exceeding 1,000 parts per million of these salts is attained in the water it has a disagreeable taste and a laxative effect on persons unaccustomed to its use. With greater thicknesses of overlying boulder clay the amounts of salts in solution in the water increase, so that in many places water from 40 feet or more in depth in the drift is unfit for drinking and may even have a tendency to create scour in stock. Wells sunk beside sloughs occurring in depressions in the boulder clay or beside excavated dugouts derive their water by seepage. The clay under such circumstances acts as a natural filter and the water if uncontaminated by decaying organic matter is generally suitable for household requirements. In places where the surface water entering the slough washes over outcrops of Bearpaw shales, or the slough occupies the bottom of an extensive undrained depression, large concentrations of mineral salts are to be expected. The clay acting as the filter will not remove salts in solution from the water.

Water from the Bedrock

Water obtained from the Ravenscrag formation occurring beneath the drift in the northern parts of the municipality is generally of good quality. The majority of the spring waters issuing from Ravenscrag sands in this municipality are believed to be similar to the water from a spring located on Bates creek about 5 miles west of the northwest corner of the municipality. An analysis of the water from this spring indicated a low total solid content of 360 parts per million, which is made up of approximately 80 parts per million each of calcium carbonate ($CaCO_3$), magnesium carbonate ($MgCO_3$), sodium sulphate (Na_2SO_4), and magnesium sulphate ($MgSO_4$), and 15 parts per million of common salt in solution. The water has a total hardness of 280 parts per million. This water is much softer than supplies generally found in either the Recent deposits or the glacial drift. The small amounts of sulphate salts present in the water make it of excellent quality for household use.

Waters obtained from wells in secs. 27 and 34, tp. 6, range 14, of this municipality are of good quality for household use and are believed to be similar to the water from a well at about the same elevation in the Ravenscrag formation in sec. 2, tp. 7, range 14, less than a mile to the north of the municipality. The analysis of the latter shows a total solid content of only 500 parts per million, made up mostly of the carbonates of calcium, magnesium, and sodium, with 127 parts per million of sodium sulphate. This water has a permanent hardness of 200 parts per million and is only moderately hard in comparison with many waters of the municipality.

No analyses have been made of water from the Eastend formation either in this municipality or in adjacent areas. It is believed, however, that due to the less porous nature of the sand beds than those of the Ravenscrag and the presence of larger amounts of readily dissolvable mineral salts, the water will contain a much higher concentration of sulphate salts. It may be that wells sunk through the Ravenscrag into the Eastend on the highest points of the uplands will encounter a soft, sodium, carbonate-bearing water. The sandy beds of the Bearpaw formation yield a water that is hard and generally has a high concentration of sulphate salts in solution. This water is in many places unsuitable for drinking due to the laxative effects of the dissolved salts. The concentration of sulphate salts and common salt is found to increase at greater depths in the shale and the water is usually unfit for any farm requirements.

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WELL RECORDS—Rural Municipality of NO. 47, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE: Above (+) Below (−) Surface	HEIGHT TO WHICH WATER WILL RISE: Elev.	PRINCIPAL WATER-BEARING BED: Depth	PRINCIPAL WATER-BEARING BED: Elev.	PRINCIPAL WATER-BEARING BED: Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
1	NW.	1	4	13	3	Dug	90	2,697	− 70	2,627	80	2,617	Glacial muck	Hard, dark colour, "alkaline"		N	Insufficient supply; another 13-foot well with "alkaline" water.
2	NE.	2	"	"	"	Dug	15	2,700					Glacial drift	Hard, "alk-aline"		D, S	Seepage from reservoir.
3	NE.	7	"	"	"	Dug	15	2,710					Glacial drift	Hard, "alk-aline"		D, S	Sufficient supply.
4	NE.	8	"	"	"	Dug	20	2,700					Glacial drift	Hard, "alk-aline"		D, S	Sufficient supply.
5	NE.	8	"	"	"	Dug	8	2,700	− 6	2,694	8	2,692	Glacial drift	Hard		D, S	
6	NW.	14	"	"	"	Dug	24	2,806	− 14	2,792	20	2,786	Glacial gravel	Soft, clear	45	D, S	Sufficient supply for 20 head stock.
7	NE.	15	"	"	"	Dug	10	2,790					Glacial drift	Hard, "alk-aline"		D, S	Sufficient for local needs.
8	SE.	17	"	"	"	Dug	20	2,680					Glacial drift	Hard		D	Only sufficient for house use.
9	NW.	18	"	"	"	Dug	7	2,640	0	2,640	3	2,637	Recent alluvium, sand	Soft, clear	45	D, S	Sufficient supply.
10	SW.	19	"	"	"	Dug	50	2,735	− 48	2,687	50	2,685	Glacial gravel	Hard, clear, "alkaline"	45	D, S	Sufficient supply; another similar well, water comes in quickly.
11	NW.	20	"	"	"	Dug	20	2,700	− 17	2,683	20	2,680	Glacial gravel	Soft, clear	45	D	Insufficient supply; another 36-foot well with hard, "alkaline" water.
12	SW.	21	"	"	"	Dug	15	2,670					Glacial drift	Hard		D, S	Sufficient supply.
13	NW.	23	"	"	"	Dug	20	2,640	− 16	2,624	20	2,620	Glacial sand and gravel	Soft, clear		D, S	Waters 10 head stock; another well, hard water. 2 dry holes SE.¼ in bedrock, 260 and 190 feet deep.
14	NE.	30	"	"	"	Dug	8	2,690	− 6	2,684	8	2,682	Recent alluvium, gravel	Hard, clear	45	D, S	Sufficient supply; two other wells in draw, also several springs.
15	NE.	31	"	"	"	Dug	20	2,652	− 18	2,634	20	2,632	Recent alluvium	Hard, clear, "alkaline"	45	D, S	Insufficient supply for 6 head stock.
16	NE.	34	"	"	"	Dug	30	2,668	− 18	2,650	30	2,638	Glacial gravel	Hard, clear		D, S	Sufficient supply.
17	SE.	35	"	"	"	Dug	14	2,843	− 12	2,831	12	2,831	Glacial gravel	Hard, clear, "alkaline"	45	D, S	Sufficient supply; another well 22 feet deep used for stock.
18	SW.	36	"	"	"	Dug	15	2,745	− 11	2,734	15	2,730	Glacial gravel	Hard, clear		D, S	Sufficient supply; supplies water for neighbours.
19		36	"	"	"	Dug	15	2,728	− 10	2,718	15	2,713	Glacial gravel	Hard, "alk-aline"		N	Water unfit for stock or house use.
		14	4	14	3	Springs							Glacial drift			S	Good supply of water.
		18	"	"	"	Springs							Glacial drift			S	Good supply of water. No settlement.
			4	15	3												No settlements in this township. Springs may be found to yield a good supply of water.
1	SW.	1	5	13	3	Dug	14	2,720	− 4	2,716	4	2,716	Glacial clay	Hard, "alk-aline"		N	Sufficient supply, but not suitable for use; 90-foot dry hole drilled, base in Bearpaw formation.
2	NW.	2	"	"	"	Dug	18	2,732	− 13	2,719	13	2,719	Glacial clay	Hard, clear, "alkaline"		D, S	Insufficient for 3 head stock; another 16-foot well near dam.
3	SE.	3	"	"	"	Dug	10	2,712	− 7	2,705	7	2,705	Glacial gravel	Hard, clear, "alkaline"		S	Sufficient for 6 head stock; unfit for human consumption.
4	NE.	4	"	"	"	Dug	15	2,758	− 11	2,747	11	2,747	Glacial gravel	Hard, clear		D, S	Waters 60 head stock; several dry holes, blue clay down to 50 feet.

NOTE—All depths, altitudes, heights and elevations given above are in feet.

(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of NO. 47, SASKATCHEWAN.

WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE: Above (+) Below (−) Surface	HEIGHT TO WHICH WATER WILL RISE: Elev.	PRINCIPAL WATER-BEARING BED: Depth	PRINCIPAL WATER-BEARING BED: Elev.	PRINCIPAL WATER-BEARING BED: Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
5	SE.	6	5	13	3	Dug	18	2,690	- 11	2,679	11	2,679	Glacial gravel	Hard, "alkaline"		D	Sufficient supply for house use; creek for stock.
6	NW.	9	"	"	"	Dug	42	2,790	- 36	2,754	42	2,748	Bearpaw shale at base?	Hard, clear, "alkaline"		S	Sufficient for 10 head stock; another similar well and a dam used.
7	SE.	9	"	"	"	Dug	16	2,715	- 9	2,706	10	2,705	Glacial gravel	Hard, clear		D, S	Sufficient for 25 head stock.
8	SE.	12	"	"	"	Drilled	125	2,798					Bearpaw shale at base				Dry hole; several shallow wells 15 feet deep, "alkaline" water unfit for stock.
1	NE.	36	5	14	3	Bored	33	2,800	- 8	2,792	33	2,767	Glacial gravel	Hard, clear, "alkaline"		D, S	Waters 30 head stock; another similar well also used.
			5	15	3												No wells known to occur in this township.
1	SW.	2	6	13	3	Dug	15	2,848	- 13	2,835	13	2,835	Glacial drift	Soft, clear		D, S	Waters 10 head stock.
2	SE.	7	"	"	"	Dug	16	2,890	- 13	2,877	16	2,874	Recent alluvium	Hard, clear		D, S	Insufficient supply.
3	NW.	18	"	"	"	Dug	18	2,835	- 14	2,821	14	2,821	Bearpaw shale	Hard, clear, "alkaline"		D, S	Sufficient supply; another well 10 feet deep used for stock.
4	NW.	21	"	"	"	Dug	35	2,966	- 25	2,941	25	2,941	Bearpaw shale	Hard, clear		D, S	Sufficient for 8 head stock.
5	NW.	22	"	"	"	Spring		2,966					? ?	Hard		S	Sufficient supply.
6		29	"	"	"	Spring		2,900?					Possibly Eastend sands	Hard		?	Yield undetermined.
7	SW.	30	"	"	"	Dug	30	2,843	- 26	2,817	26	2,817	Bearpaw shale	Hard, "alkaline"		D, S	Waters 20 head stock.
8	SW.	32	"	"	"	Dug	35	2,902	- 30	2,872	30	2,872	Eastend shale	Hard, clear		D, S	Waters 10 head stock.
1	NE.	1	6	14	3	Dug	22	2,832	- 16	2,816	16	2,816	Recent alluvium, sand	Hard, clear, "alkaline"	45	D, S	Insufficient supply for 30 head stock.
2	NW.	1	"	"	"	Dug	46	2,830	- 28	2,802	46	2,784	Bearpaw sandstone	Hard, clear, "alkaline"		D, S	Sufficient for 30 head stock.
3	NE.	12	"	"	"	Dug	14	2,800	- 10	2,790	14	2,786	Bearpaw shale	Hard, "alkaline"		D, S	Sufficient supply. Several 50-foot wells across valley, water from 8 to 10 feet.
4	NW.	13	"	"	"	Dug	12	2,875			12	2,863	Glacial drift(?)	?			Sufficient supply of water.
5	SE.	14	"	"	"	Dug	50	?	?	?	?		Bearpaw shale	Strongly "alkaline"		N	No knowledge regarding aquifer.
6	NW.	23	"	"	"	Bored	50	2,970	- 40	2,930	40	2,930	Eastend sand	Soft, clear		D, S	Sufficient supply; stock watered in coulée.
7	SE.	24	"	"	"	Dug	16	2,828	- 12	2,816	12	2,816	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient supply; at least 30 head stock watered.
8	NE.	24	"	"	"	Dug	65	2,890	- 40	2,850	50	2,840	Bearpaw sand	Hard, clear, "alkaline"	45	S	Sufficient supply for 15 head stock. Seepage well in creek supplies drinking water.
9	NE.	27	"	"	"	Bored	77	3,030	- 65	2,965	77	2,953	Ravenscrag sand	Soft, clear		D, S	Sufficient supply; dry holes to 75 feet.
10	SE.	30	"	"	"	Bored	135	2,935	-133	2,802	135	2,800	Bearpaw shale	Hard, "alkaline"	45	S	Insufficient supply; waters 14 head stock
11	SE.	34	"	"	"	Bored	90	3,040	- 80	2,960	90	2,950	Ravenscrag sand and sandstone	Hard, clear	45	D, S	Sufficient supply; another well 34 feet deep went dry.
12	NW.	35	"	"	"	Dug	12	3,000	- 6	2,994	6	2,994	Glacial sand	Hard, clear, "alkaline"	45	D, S	Waters 32 head stock; also use a spring for stock.

NOTE—All depths, altitudes, heights and elevations given above are in feet.

(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.

WELL RECORDS—Rural Municipality of NO. 47. SASKATCHEWAN.

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WELL No.	LOCATION ¼	Sec.	Tp.	Rge.	Mer.	TYPE OF WELL	DEPTH OF WELL	ALTITUDE WELL (above sea level)	HEIGHT TO WHICH WATER WILL RISE Above (+) Below (−) Surface	Elev.	PRINCIPAL WATER-BEARING BED Depth	Elev.	Geological Horizon	CHARACTER OF WATER	TEMP. OF WATER (in °F.)	USE TO WHICH WATER IS PUT	YIELD AND REMARKS
13	NW.	36	6	14	3	Dug	6	2,972	- 2	2,970	2	2,970	Alluvium, sand and gravel	Hard, clear, "alkaline"	45	D, S	Sufficient supply for 4 head stock.
14	SE.	36	"	"	"	Dug	14	2,872	- 8	2,864	8	2,864	Glacial sand	Hard, clear, "alkaline"		D, S	Sufficient supply for 100 head stock.
1			6	15	3	Springs											There are no wells in the township, but numerous springs are found along the valleys.

NOTE—All depths, altitudes, heights and elevations given above are in feet.

(D) Domestic; (S) Stock; (I) Irrigation; (M) Municipality; (N) Not used.
(#) Sample taken for analysis.